Claims

1. A method of analysing at least one parameter of a body component, comprising the steps of illuminating the component or body with light of at least a first and second waveband, receiving light of at least said first and second wavebands remitted by the component at a photoreceptor or photoreceptors, and analysing the light received at the photoreceptor(s) to provide a ratio between the amount of light remitted of the first waveband and the amount of light remitted of the second waveband, and from this calculating the component parameter.

2. A method according to claim 1, in which the wavebands are predetermined and calculated by use of a mathematical model of the body component and its characterising parameters.

3. A method according to claim 1, in which the wavebands are predetermined and derived through use of a biological model of the body component.

4 A method of analysing at least one parameter of a body component, comprising the steps of illuminating the body or component with light of at least a first and second waveband, receiving light of at least said first and second wavebands remitted by the component at the photoreceptor(s), but eliminating light reflected by the component or body and analysing the light received at the photoreceptor(s) to provide a ratio between the amount of light of the first waveband and the amount of light of the second waveband, and from this calculating the component parameter.

5 A method according to any of the preceding claims where the wavebands are chosen such that the component parameter is a one to one function of the ratio between the amount of light remitted by the body

component of the first waveband and the amount of light remitted by the component of the second waveband.

6 A method according to any of the preceding claims, in which the waveband ratios are compared with a mathematically generated model of waveband ratios corresponding to a range of component parameters.

7 A method according to any of the preceding claims, in which the waveband ratios are compared with an experimentally measured set of waveband ratios corresponding to a range of component parameters.

8 A method according to claims 6 or 7 where the comparison results in a measure or measures relating to the component parameter or parameters.

9 A method according to any of the preceding claims where a function is derived relating the computed ratios and the component parameter or parameters.

10 A method according to any of the preceding claims, in which the light reflected by the component is eliminated by the use of a pair of cross polarised linear polarizing filters, one filter being placed between the source of illumination and the component, and the other filter placed between the component and the photoreceptor or photoreceptors.

11. A method according to any of the preceding claims in which the light illuminating the body component is a light of a plurality of wavelengths which includes at least the wavebands.

12 A method according to claim 11 in which the illuminating light is ambient light.

13 A method according to claim 11 in which the illuminating light is sunlight.

14. A method according to claims 11 - 13, in which at least one filter is placed sequentially between the source of illumination and the component or between the component and the photoreceptor or photoreceptors.

15. A method according to any one of the preceding claims, in which the body component is human or animal tissue.

16. A method according to claim 15, in which the tissue is one of skin, the lining of the gut, colon, oesophagus, cervix, eye or any other epithelial tissue.

17. A method according to any one of the preceding claims, for analysing a plurality of body component parameters where the component is illuminated with light of each of a collection of wavebands. The light received by the photoreceptor or photoreceptors includes this collection of wavebands. The light is analysed at the photoreceptor(s) to provide a collection of ratios between the amount of light of each waveband with some or all of the other wavebands and from this calculating the component parameter(s).

18. A method according to any one of the preceding claims, for analysing a plurality of body component parameters in which for each component parameter there exists a pair of predetermined wavebands such that the component parameter is a one to one function of the ratio between the amount of light remitted by the component of the first predetermined waveband of the pair and the amount of light remitted by the component of the second predetermined waveband of the pair, and the component is illuminated with light of each pair of predetermined wavebands, the light received by the photoreceptor or photoreceptors is of each pair of predetermined wavebands remitted by the component at the photoreceptor(s), and analysing the light received at the photoreceptor(s) to

provide for each component parameter a ratio between the amount of light of the first waveband and the amount of light of the second waveband, and from this calculating each component parameter.

19 A method according to claim 17 or 18, in which the waveband ratios are compared with a mathematically generated model of waveband ratios corresponding to a range of component parameters to ascertain the component values.

20 A method according to claim 17 or 18, in which the waveband ratios are compared with an experimentally measured set of waveband ratios corresponding to a range of component parameters to ascertain the component values.

21 A method according to claims 19 or 20 where the comparison results in a measure or measures relating to the component parameter or parameters.

22 A method according to claims 19 or 20 where a function is derived relating the computed ratios and the component parameter or parameters.

23. A method according to any of the preceding claims in which the body component is skin and the parameters are the concentration of melanin and the concentration of blood.

24. A method according to claim 23, in which the predetermined wavebands are the Red, Green and Blue colour bands, with the three wavebands providing the two ratios which are a one to one function with the parameters.

25. A method according to any one of the preceding claims, in which the predetermined wavebands have been calculated by the steps of:

1) defining a set of potential wavebands

2) defining one or more image ratios, the or each image ratio for a region being obtained by dividing the amount of light remitted by the component of a given waveband for that region, the "image value" for that filter, by another image value for that same region;

3) for a component parameter to be analysed and for said defined set of potential wavebands and for said given image ratios, obtaining a function mapping points in parameter space to points in image ratio space;

4) determining whether the mapping function provides a 1:1 correspondence between points in parameter space and points in image ratio space; and

5) if the mapping function does not provide a 1:1 correspondence, rejecting said potential wavebands, repeating steps 1) to 4) and, if the mapping function does provide a 1:1 correspondence accepting the potential wavebands as a candidate set of predetermined wavebands.

26. Apparatus for analyzing at least one parameter of component, comprising a light source for illuminating the component with light of at least a first and second predetermined waveband, a photoreceptor or photoreceptors for receiving light of at least said first and second predetermined wavebands remitted by the component reflected by the surface at a photoreceptor or photoreceptors; surface reflection elimination means for eliminating light reflected by the surface of the component and means for analyzing the light received at the photoreceptor(s) to provide a ratio between the light of the first waveband and the light of the second waveband , and from this calculating the component parameter.

27 A method according to claim 26 where the predetermined wavebands are chosen such that the component parameter is a one to one function of the ratio between the amount of light remitted by the component of the first predetermined waveband and the amount of light remitted by the component of the second predetermined waveband.

28. Apparatus according to claim 26, in which the photoreceptor comprises a digital camera.

29. Apparatus according to claim 28, in which the digital camera includes a plurality of filters, one for each predetermined waveband.

30. Apparatus according to claim 26 in which the light source is ambient light.

31. Apparatus according to claim 27, 28, 29 or 30, in which the distance between the photoreceptor(s) and the component is between 0.5cm and 10m.

32. Apparatus according to any one of claims 33 to 34, in which the distance between the light source and the component is between 0.5cm and 10m.

33. A method for deriving a pair of predetermined wavebands suitable for use in analysing a given parameter of a body component, the method comprising the steps of:

1) defining a set of potential wavebands

2) defining one or more image ratios, the or each image ratio for a region being obtained by dividing the amount of light remitted by the component of a given waveband for that region, the "image value" for that filter, by another image value for that same region;

3) for the parameter of the component to be analysed and for said defined set of potential wavebands and for said given image ratios, obtaining a function mapping points in parameter space to points in image ratio space;

4) determining whether the mapping function provides a 1:1 correspondence between points in parameter space and points in image ratio space; and

5) if the mapping function does not provide a 1:1 correspondence, rejecting said potential wavebands, repeating steps 1) to 4) and, if the mapping function does provide a 1:1 correspondence accepting the potential wavebands as a candidate set of predetermined wavebands.

34. A method according to claim 33 and comprising, for a set of potential wavebands accepted as a candidate set of wavebands, determining the accuracy of parameter recovery obtained using said mapping function and determining whether or not the accuracy is sufficient or matches some other criterion.

35. A method according to claim 34, wherein if the accuracy is sufficient or matches said criterion, the candidate wavebands are adopted and if the accuracy is not sufficient or does not match said criterion, steps 1) to 5) are repeated for a different set of wavebands.

36. A method according to claim 34 or 35, wherein the accuracy is determined by:

a) calculating the error associated with image acquisition for each vector of each image ratio;

b) from the image ratio vector error, calculating the maximum possible error in each component of the parameter vector across the whole of parameter space; and

c) using the vector of parameter errors at each point within parameter space to measure the accuracy of parameter recovery.

37. A method according to claim 33 or 34 and comprising repeating steps 1) to 5) for a multiplicity of sets of potential wavebands to identify a plurality of candidate waveband sets, determining for each candidate set an

error value representing the accuracy of parameter recovery obtained using the corresponding mapping function, and using said candidate set as a basis for determining a preferred set of wavebands.

38 A method according to claim 37 and comprising using a genetic algorithm to determine a preferred set of wavebands using said candidate set.

39. A method according to any one of claims 33 to 35 and comprising using a gradient descent algorithm to select an optimal set of wavebands, the starting point for the algorithm being a first candidate set of wavebands identified in step 4).

40. A method according to any one of claims 33 to 39, wherein for each waveband the method of the present invention is used to determine the center wavelength of the waveband.

41. A method according to any one of claims 33 to 40, wherein the method is used to determine the full width half maximum (FWHM) of the waveband.

42. A method according to any one of claims 33 to 41, wherein step 3) comprises constructing a Jacobian matrix for the mapping function with respect to said parameter(s), and obtaining the determinant of that matrix.

43. A method of determining a property or properties of each of a set of filters, which filters are used to select specific wavelength ranges in a system which relies upon a spectral analysis of remitted, emitted, and/or transmitted light to quantify a parameter or parameters of an object or material, the method comprising the steps of:

1) defining a set of potential filter properties

2) defining one or more image quotients, the or each image quotient for a region being obtained by dividing the quantified output of a given filter for that region, the "image value" for that filter, by another image value for that same region;

3) for an object or material to be analysed and for said defined set of potential filter properties and for said given image quotients, obtaining a function mapping points in parameter space to points in image quotient space;

4) determining whether the mapping function provides a 1:1 correspondence between points in parameter space and points in image quotient space; and

5) if the mapping function does not provide a 1:1 correspondence, rejecting said potential filter properties, repeating steps 1) to 4) and, if the mapping function does provide a 1:1 correspondence accepting the potential filter properties as a candidate set of filter properties.

44. Apparatus for analysing an object or material having means for conducting a spectral analysis of remitted, emitted, and/or transmitted light to quantify a parameter or parameters of an object or material, the apparatus comprising a plurality of filters for splitting said light into respective components, the filters having properties obtained by using the method of the claim 43.